APPENDIX R

2004-2007 Report

Potential Off-road Vehicle Impacts on Bird Populations within Microphyll Woodlands at the Algodones Dunes

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INTRODUCTION

This report summarizes findings from four springs of point count surveys (2004-2007) that were conducted for the El Centro Bureau of Land Management (BLM) Field Office. Surveys focused on Blue Palo Verde (*Parkinsonia florida*)/ Ironwood (*Olneya tesota*) woodlands situated east of the Algodones Dunes, Imperial County, CA (Figure 1). These woodlands host vegetation assemblages similar to those found in washes and arroyos across the Sonoran Desert, and may be referred to as *microphyll woodland*, *xeric riparian* or *xeroriparian woodland*, or *Sonoran Desert thornscrub woodland*, depending on the particular source of information and on the physiography of the particular site. Surveys were designed to assess potential effects of off-highway vehicle use on the migrant and breeding birds that depend on microphyll woodlands for survival.

In *A Natural History of the Sonoran Desert* (2000), Mark Dimmitt wrote that "dry washes occupy less than five percent of this subsection (the Lower Colorado River subsection) of the Sonoran Desert, but support ninety percent of its bird life (8)." Yet New Mexico's *Comprehensive Wildlife Conservation Strategy* (2006) states that "the condition of xeric riparian communities is largely unknown," and that "though acknowledged as important habitat, relatively few studies have focused on these habitat types. (226)." It is critical that we inventory and quantify bird populations of these under-studied habitats in the face of increasing anthropogenic pressures in the Desert Southwest.

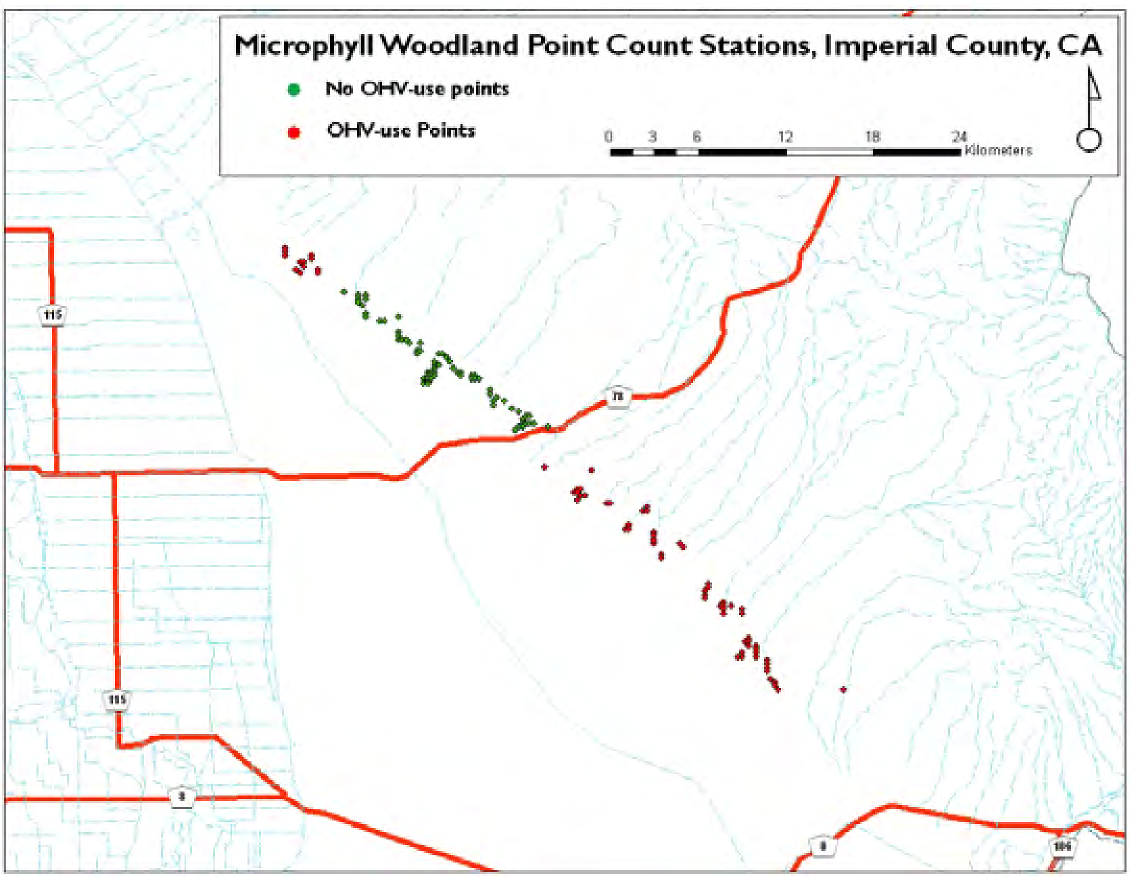

Figure 1. Point count stations initiated by the BLM El Centro Field Office, east of the Algodones Dunes.

SUMMARY

The El Centro BLM Field Office initiated 139 point count stations across microphyll woodlands east of the Algodones Dunes and due to funding limitations, surveyed 70 of them from 2004-2007 (Figures 2a-c). In sum, we found significantly (p<0.05) higher abundances of both migrants and breeders in areas where off-highway vehicle use is not allowed, and of the 18 most common species, seven were significantly more abundant in areas where off-highway vehicle use is not permitted. Only one species (Verdin) were significantly more abundant in areas with OHV use, but as will be explained, this Verdin result may be spurious.

Migrant abundance, richness, and diversity, were all positively correlated to winter precipitation, and migrant and breeding abundance were negatively correlated with temperature. Migrant response to precipitation at the Algodones Dunes matched patterns found across PRBO's woodland sites (CM *in prep*), where migrant abundance and diversity at sites farthest from true riparian areas such as the Colorado River respond most strongly to changes in winter precipitation.

Though there were significantly more breeders and migrants in areas where OHV-use is not permitted, there is circumstantial evidence in the data that suggest that the "best" habitat in the study area is in areas closed to OHV-use.

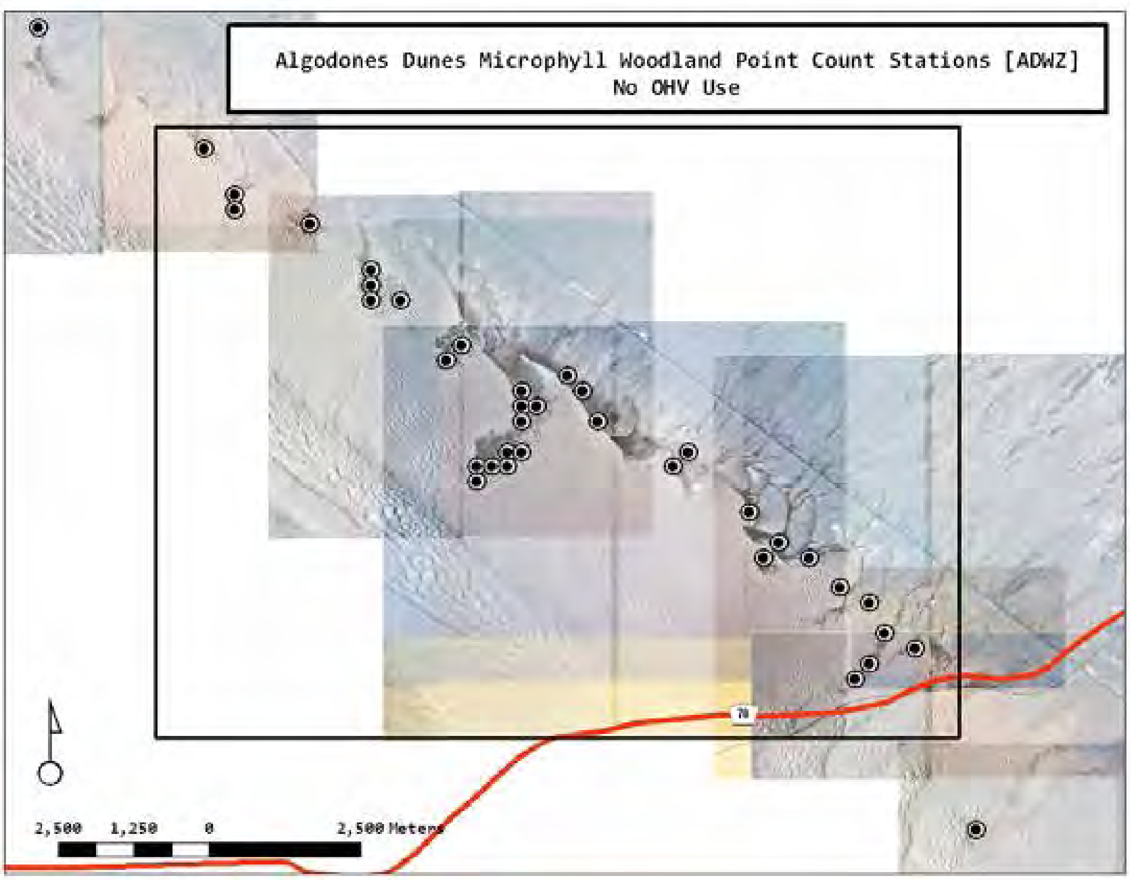

Figure 2a. Thirty-five points have been surveyed from 2004-2007 inside the North Algodones Dunes Wilderness, where no OHV use is allowed.

The four-year span of these surveys covered a period of average precipitation (2004), well above-average winter and spring rainfall (2005), and two consecutive winters of intense drought with lower temperatures (2006-2007). Our analyses focus on potential effects of winter/spring precipitation (Nov. 1 through May 31), winter temperature (January through March), and off-highway vehicle (OHV)-use management regime (no use allowed or use permitted) on migrant and breeder abundance, richness, and diversity across the study area.

Importantly, no vegetation data have been collected for surveyed sites.

Surveyors detected 70 species during point count surveys over the course of four seasons (Appendix A). The addition of these sites to a concurrent study conducted by PRBO in microphyll woodlands of the Lower Colorado River Valley (270 stations in Arizona and 410 in California) provides a complete regional baseline of breeding and migrant bird populations on washes of the Lower Colorado River Valley section of the Sonoran Desert.

We found that as of 2007, there are generally not enough data to assess detectability and generate abundance estimates with program DISTANCE (we therefore used estimates generated with assumed constant detection β=1). We recommend that the BLM survey all 139 stations in the study area to increase sample size, and to record all distances to the exact meter. Until vegetation at all sites is assessed, it is questionable to assume that any differences in demographic parameters between open and closed sites stem from recreation pressure and not habitat differences.

In addition, McCreedy (2006) found that OHV use can vary greatly within management units, and that closed areas may have substantial illegal use, while open areas may occasionally have no use. We recommend that the BLM record annual OHV-use data at all points, such as distance to active trail or trail density, in order to better assess recreation pressure across the study area.

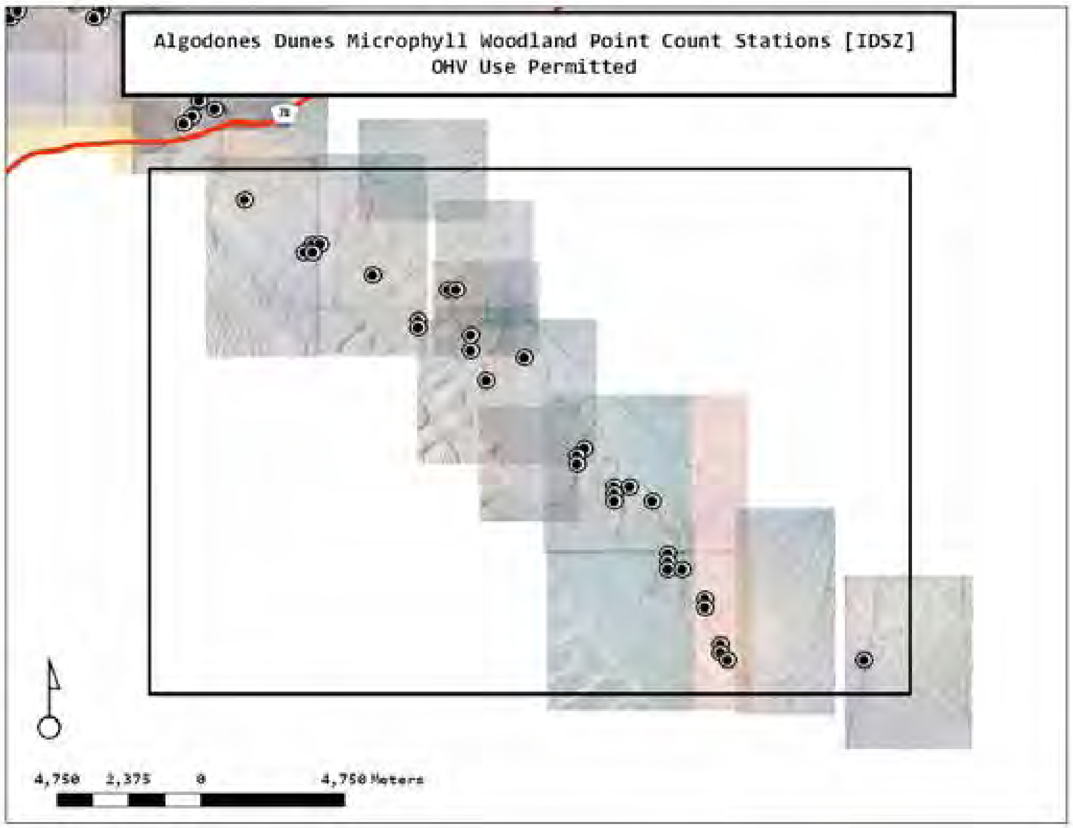

Figure 2b. Thirty-two points have been surveyed from 2004-2007 south of the North Algodones Dunes Wilderness, here OHV use is allowed.

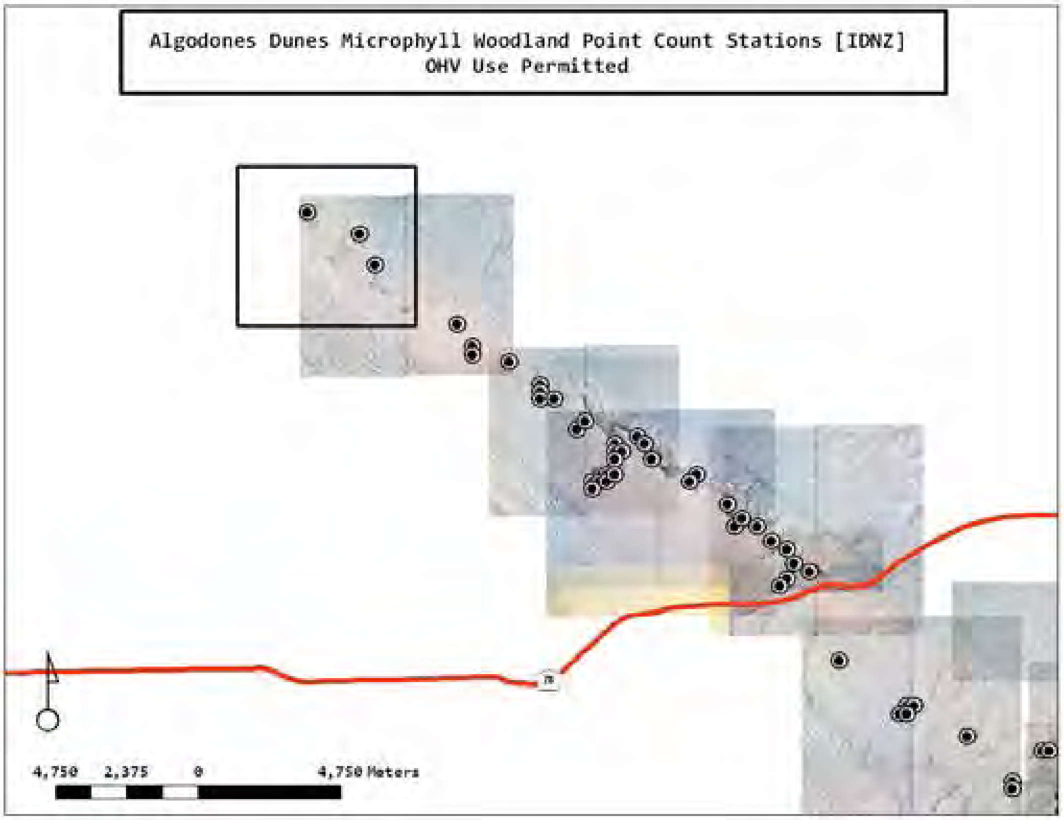

Figure 2b. Three points have been surveyed from 2004-2007 north of the North Algodones Dunes Wilderness, here OHV use is allowed.

METHODS

1.1 Point Count Censuses

Using and expanding upon a grid of stratified-random points generated by the California BLM in 2002 (McCreedy 2004), the BLM conducted censuses in microphyll woodland at 70 point count stations in central Imperial County, east of the Algodones Dunes (Figures 2a-c). All point count stations were placed within 50 m of microphyll woodland. Point count station names, UTM (NAD83) coordinates, and dates surveyed are presented in Appendix B. Points within the North Algodones Dunes Wilderness were coded "ADWZ", and points north and south of the wilderness area coded "IDNZ" and "IDSZ" respectively.

The BLM conducted 5-minute Variable Circular Plot point counts following standards recommended by Ralph et al. (1993 and 1995) and Fancy and Sauer (2000). Distance to each detection was measured using a Leica Rangefinder LRF800, (all detections greater than 100 m were lumped as "greater than 100" to avoid false precision), or labeled as "flyover" if the individual was seen as in transit and not using the habitat. Each station was visited twice during peak bird breeding season (between April 1 and April 30), and visits were at least 15 days apart.

All stations were counted by biologists familiar with the songs and calls of the birds in the area. When feasible, stations were surveyed in opposite order between visits, in order to minimize effects of time of day on detection rates. Censuses were conducted from within 30 minutes after local sunrise until approximately 4 hours later, and were not conducted in excessively windy or rainy conditions. Detections were categorized as song, visual, or call (drumming woodpeckers, flushing doves, and displaying hummingbirds were exceptions, and were categorized as 'drumming', 'wing beats', or 'displaying').

1.2 Weather Data

Weather data were collected at Cahuilla RAWS station near the intersection of Gecko Road and California State Highway 78 (UTM NAD 83: 670768e/3649810n). The Cahuilla station is at an equitable elevation to the study site (278 feet above Sea Level) and is only 3.5 miles from the nearest point count station. Because weather variables have a tendency to be highly correlated, we limited our analyses to two variables which we felt would be biologically important in this system based on our experience in other xeric systems: we calculated the average temperature from January through March of the year data were collected, and rainfall from November 1 of the previous year through May 31.

1.3 Statistical Analysis and Definitions

Species Richness, Species Diversity, and Species Abundance

We calculated species diversity and species richness using two bird population datasets: 1.) all species detected (migrants and breeders) and 2.) a subset of 45 breeding species. We did not include flyover detections in analyses. A list of breeding species is provided in Appendix D, and was generated from confirmed breeding at California and Arizona sites from 2003-2007.

Species Diversity

We calculated species diversity for each point count station and each wash grid using all detections within 100 m, summed over two visits. We used the transformed Shannon-Wiener index of biological diversity, denoted N_1 (MacArthur 1965, Krebs 1989). This index of diversity is usually highly correlated with bird species richness, but also takes the number of individuals of each species into account. Higher scores on the Shannon-Wiener index indicate higher species richness and more balanced numbers of individuals of each species added. Expressed mathematically:

$$N_1 = e^{H'} \text{ and } H' = \sum_{i=1}^{i=S} (p_i)(\ln p_i)(-1)$$

Where S = total species richness and p_i is the proportion of the total numbers of individuals for each species (Nur et al. 1999). High index scores indicate both high species richness and more equal distribution of individuals among species.

Species richness

We calculated the number of species for each point count station and each wash grid, using all detections within 100 m, summed over two visits.

By-species Abundance

We calculated the mean number of individuals detected, averaged over the entire wash grid, then averaged over two visits, using all detections within 100 m. Because few species are 100% detectable, such calculations may underestimate absolute density. Therefore results should be considered minimum estimates of abundance.

Species diversity, richness, and relative abundance summaries were conducted using Point Count 2.75 (Ballard 2002).

Maximum likelihood models

Background: Analyzing trends with only four years of data may lead to spurious results and is generally not recommended or informative as a greater number of years are needed to detect trends (Nur et al. 1999, Sokal and Rohlf 1995). At the same time, there was obviously annual variation in the data that we wanted to explore. We opted to examine the effect of three independent variables: rain fall from November through May, mean temperature (January-March), and OHV status. We conducted maximum likelihood analyses in SAS using PROC GENMOD (SAS Institute 2001) and we assumed constant detectability to 100m.

Ordinary least squares (OLS) method for analyzing count data is not generally appropriate because count data are seldom normally distributed (Cameron and Trivedi 1998). Maximum likelihood approaches using a Poisson or negative binomial distribution and a log link are preferable because they do not assume a normal distribution and they are suitable for ill-dispersed data. Poisson regression is appropriate when the mean and variance are equally dispersed, whereas negative binomial regression can be used to model over- or under-dispersed data.

Selection of distribution: We first evaluated the fit of both the Poisson and negative binomial distribution by comparing the deviance and log-likelihood values for both models in order to select the best distribution. Once we selected the best distribution (negative binomial or Poisson) for a given model, we evaluated the overall goodness of fit of the model based on the ratio of deviance divided by the number of degrees of freedom. When this ratio is close to or less than one, model fit is very good. Large ratio values may indicate model misspecification or an over-dispersed response variable indicating a less optimal fit (ratio > 2.0).

Dependent variables: Once we selected the appropriate distribution, we modeled the effects of the three independent variables on dependent variables relating to avian abundance, species diversity, and species richness. We first examined effects on pooled species abundance, pooled diversity and pooled species richness for all birds. However, because migrants and breeders may react differently to annual or climatic patterns we also calculated pooled abundance, diversity, and richness separately for migrants and breeders. Additionally we analyzed abundance for the 18 species with 50 or greater detections (Appendix A).

Significant covariates: For each dependent variable we evaluated the effects of OHV use, rain, and winter temperature using PROC GENMOD with a Type3 analysis (analogous to Type III sums of squares in OLS regression; Allison 1999). The Type3 analysis computes likelihood ratio statistics to analyze the significance of each covariate in a manner that does not depend on the order of the specified terms. We considered covariates to be statistically significant if $p < 0.05$; however we show p-values 0.05>x <0.10 in the tables.

Incidence rate ratio: We used a contrast estimate statement in PROC GENMOD to evaluate the incidence rate ratios for sites with and without OHV use, as well as to evaluate the effect of increasing temperature or increasing rainfall by one unit. To calculate the incidence rate ratio we exponentiated the parameter estimates and standard errors from the Type3 analysis. (Parameter estimates must be exponentiated because Poisson and negative binomial regression both use a log link so one needs to transform to the appropriate units and scale).

Mean OHV effect: For models in which OHV status was a significant predictor (based on *Significant Covariates*, above), we calculated the least square mean (lsmean) for abundance (or diversity/richness) at sites where OHV-use was allowed and not allowed. Lsmeans are the mean for a variable (e.g. abundance) after adjusting for the other variables in the model (i.e. temperature and rainfall). We present transformed (exponentiated) values for the lsmeans.

Analyses of density using Distance

Selection of detection function: We used the program DISTANCE (Buckland et al. 2001) to compare density between OHV use and non-use sites for the 10 most abundant species (Appendix A), as well as for Brown-headed Cowbirds, which are a species of management concern. We fit a detection function for each species pooled across all years and specified a hazard-rate key function with a hermite polynomial expansion; the maximum number of adjustments was constrained to 2 because of the limited number of distance bins. We also explored using other key functions such as uniform and half-normal, both with and without cosine adjustments, but the hazard-rate key function was most supported by the data, based on ΔAICc values. We evaluated the goodness of fit of the detection function for each species using chi-square. A non-significant test indicated that the data fit the function well. In most cases the detection functions had a significant GOF test indicating that the function did not fit the data well. This was generally due to heaping in the data at one or more distance categories (discussed later).

We calculated models for each species with all data pooled as well as a stratified model which accounted for OHV status and year. We compared the pooled and stratified models for each species and the best model was determined by lowest ΔAICc score. We calculated density and 95% confidence intervals for each species for each level of year (2004-2007) and OHV status (present or absent) for a total of 8 levels of stratification.

RESULTS AND DISCUSSION

2.1 WEATHER DATA

Though we do not have long-term averages for the Cahuilla RAWS station, the 2004-2007 winter/spring precipitation matched patterns seen at other sites in the region: a near-normal winter and spring in 2004; a very wet 2005; and extreme drought in 2006 and 2007 (Figure 4). Temperature patterns also matched regional patterns during the study's duration (Figure 5).

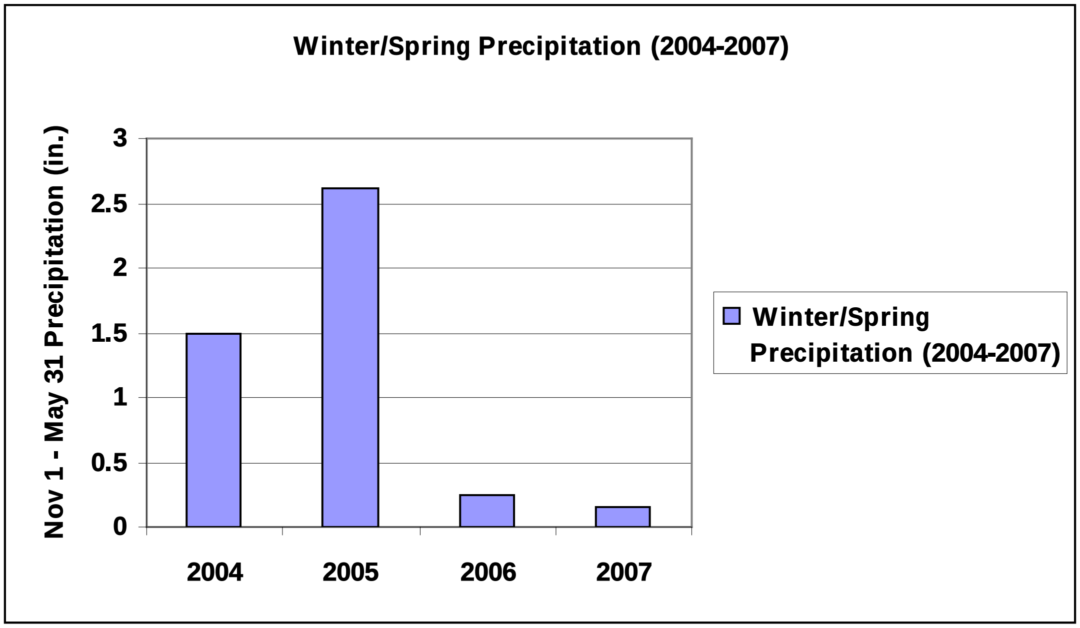

Figure 4. November 1 through May 31 precipitation recorded at the Cahuilla RAWS station, 2004-2007.

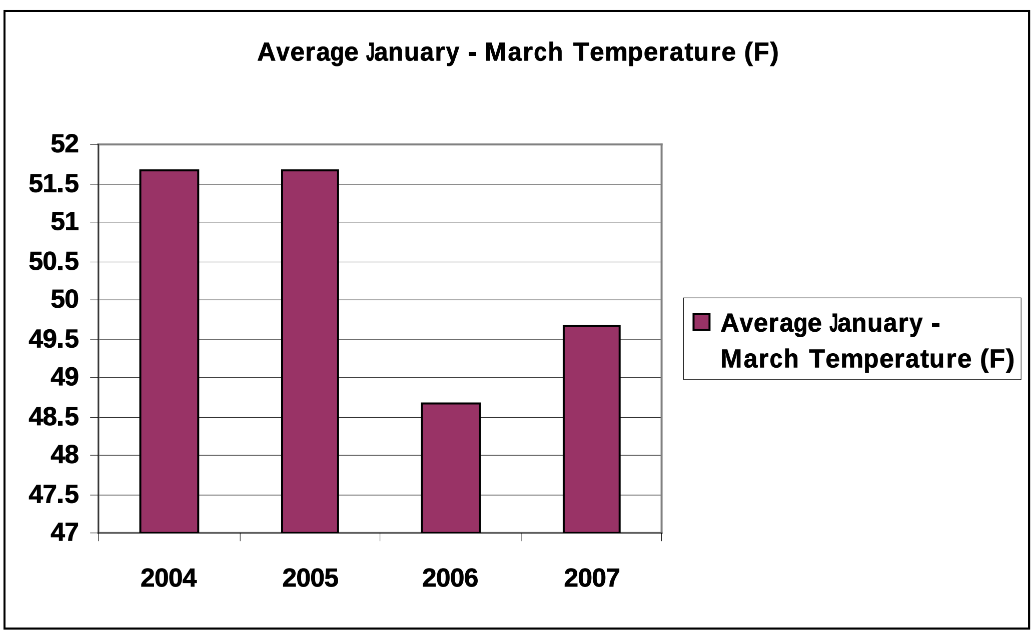

Figure 5. January through March mean temperatures recorded at the Cahuilla RAWS station, 2004-2007.

2.2 SPECIES OF CONCERN

Surveyors detected 11 sensitive species, including 2 California State Endangered Gila Woodpeckers within the Algodones Dunes Wilderness (Table 1). McCreedy (2006) reported a small population of Gila Woodpeckers annually nesting at the Milpitas Wash, only 45 km from the Algodones Dunes Wilderness, and it is possible that this species may nest in the study area.

Table 1. Species of concern detected during spring surveys, 2004-2007. Breeding species in **bold** type.

Common Name	California BSSC	National PIF Watch List	Audubon 2007 Watch List
Northern Harrier	Yes		
Gila Woodpecker	**State Endangered**		
Costa's Hummingbird		**range restricted**	**Yellow list**
Calliope Hummingbird		threatened and declining	Yellow list
Rufus Hummingbird		threatened and declining	Yellow list
Loggerhead Shrike	**Yes**		
Crissal Thrasher	**Yes**		
Lucy's Warbler	**Yes**	**range restricted**	**Yellow list**
Yellow Warbler	Yes		
Brewer's Sparrow		threatened and declining	Yellow list
Yellow-headed Blackbird	Yes		

California Bird Species of Special Concern (http://www.prbo.org/cms/docs/ecol/criteria.pdf)
PIF WL = Partners In Flight Watch List (http://www.abcbirds.org/pif/pif_watch_list.htm)
Audubon WL = Audubon 2002Watch List (http://www.audubon.org/bird/watchlist/index.html)

2.3 BREEDING AND MIGRANT PARAMETER ESTIMATES

Maximum likelihood models

Selection of distribution: We evaluated 27 separate models related to avian abundance, diversity, and richness for individual, pooled, and the total number of species (Table 2). The negative binomial distribution had the best fit for 16 models and the Poisson distribution had the best fit for 11 models. In general, model fit was very good with the ratio of deviance to degrees of freedom approaching or equaling 1.0 for most models and never exceeding 2.0. We also examined the parameter estimates and standard errors for all models to check for unusually large values (e.g. >50) as these can be evidence of ill-dispersion and/or poor model fit, but we did not encounter any problems.

Table 2. The effects of OHV status, rainfall, and temperature on avian abundance, diversity, and richness for individual, pooled, and total number of species. Shading indicates statistical significance.
[a] For all models DF=274.
[b] Significance of effect based on chi-squared statistic from likelihood ratio test; DF=1 for each test.

Model	Distribution	Deviance /DF ratio [a]	OHV [b]	Rain [b]	Temp [b]
Total abundance	neg binomial	1.05	<0.0001	ns	<0.0001
Total S-W Diversity	neg binomial	1.00	ns	0.053	0.0007
Total richness	neg binomial	1.02	0.0195	0.049	<0.0001
Migrant abundance	neg binomial	1.10	<0.0001	0.0017	<0.0001
Migrant S-W Diversity	neg binomial	1.13	ns	0.0038	<0.0001
Migrant richness	neg binomial	1.12	ns	0.0017	<0.0001
Breeder abundance	neg binomial	1.04	<0.002	ns	0.0093
Breeder S-W Diversity	poisson	0.66	ns	ns	ns
Breeder richness	poisson	0.91	0.035	ns	0.055
MODO	neg binomial	1.08	0.0005	0.0246	ns
ATFL	neg binomial	1.01	ns	ns	ns
BRSP	neg binomial	0.51	0.0002	ns	ns
GAQU	neg binomial	0.70	ns	0.0259	0.0048
BTGN	neg binomial	1.08	0.09	0.0031	0.0632
VERD	neg binomial	1.02	0.022	ns	ns
WCSP	neg binomial	0.42	ns	0.0071	ns
CACW	neg binomial	0.98	0.0219	0.0889	0.0914
OCWA	poisson	1.62	0.0006	ns	<0.0001
BUOR	poisson	1.63	ns	<0.0001	ns
WAVI	poisson	1.51	<0.0001	0.0058	<0.0001
NAWA	poisson	1.56	0.053	0.0003	ns
WIWA	poisson	1.09	ns	ns	0.0047
LBWO	poisson	0.92	ns	ns	ns
WEFL	neg binomial	0.71	ns	0.0795	ns
BHCO	poisson	1.04	0.004	ns	0.017
LOSH	poisson	0.83	0.006	0.0016	0.0031
BHGR	poisson	0.85	ns	ns	0.0014

Significant covariates:
OHV status, rainfall, and temperature were all significant predictors of pooled abundance, diversity, and richness; migrant abundance, diversity, and richness; breeder abundance and richness (Table 2).

Table 3. Incidence rate ratios and standard errors (in parentheses) for OHV status, rainfall, and temperature effects on avian abundance, diversity, and richness for individual, pooled, and total number of species. All values have been log transformed. Shading indicates statistically significance variables identified in significant covariate analysis (Table 2).

Model	OHV [a]	Rain [b]	Temp [c]
Total abundance	0.69(0.06)	1.08(0.06)	0.74(0.05)
Total S-W Diversity	0.95(0.05)	1.08(0.04)	0.85(0.04)
Total richness	0.87(0.05)	1.09(0.05)	0.81(0.04)
Migrant abundance	0.50(0.09)	1.45(0.17)	0.53(0.07)
Migrant S-W Diversity	0.89(0.11)	1.29(0.11)	0.62(0.06)
Migrant richness	0.91(0.10)	1.33(0.12)	0.59(0.06)
Breeder abundance	0.77(0.06)	0.97(0.06)	0.84(0.06)
Breeder S-W Diversity	0.93(0.06)	1.02(0.04)	0.95(0.05)
Breeder richness	0.89(0.05)	1.00(0.04)	0.92(0.04)
MODO	0.54(0.10)	0.76(0.09)	0.96(0.14)
ATFL	1.08(0.10)	0.91(0.06)	1.01(0.08)
BRSP	0.21(0.08)	1.13(0.30)	0.72(0.22)
GAQU	0.75(0.22)	1.56(0.31)	0.49(0.11)
BTGN	1.28(0.19)	0.73(0.08)	1.23(0.14)
VERD	1.46(0.24)	0.90(0.11)	0.96(0.13)
WCSP	0.77(0.31)	2.10(0.53)	1.11(0.36)
CACW	0.67(0.12)	1.22(0.15)	0.79(0.11)
OCWA	0.54(0.09)	1.20(0.19)	0.46(0.08)
BUOR	0.75(0.13)	0.44(0.08)	1.20(0.19)
WAVI	0.31(0.07)	1.74(0.35)	0.25(0.06)
NAWA	0.69(0.14)	0.55(0.10)	1.28(0.22)
WIWA	0.91(0.20)	0.96(0.19)	0.57(0.12)
LBWO	1.04(0.24)	0.90(0.14)	1.20(0.21)
WEFL	1.08(0.26)	0.67(0.16)	0.82(0.18)
BHCO	0.48(0.13)	1.22(0.23)	0.60(0.13)
LOSH	0.47(0.13)	1.80(0.35)	0.51(0.12)
BHGR	0.35(0.39)	1.40(0.33)	0.45(0.12)

[a] Incidence rate modeled as OHV-use site relative to OHV non-use site, assuming other variables are constant.
[b] Incidence rate modeled as change in dependent variable relative to a 1 unit increase in rainfall, assuming other variables are constant.
[c] Incidence rate modeled as change in dependent variable relative to a 1 unit increase in temperature, assuming other variables are constant.

Incidence rate ratio:

Incidence rate ratios (Table 3) reveal positive or negative correlations. For example:

- Total abundance was a factor of 0.69 less on OHV-use sites relative to non-use sites.
- Verdin abundance was 46% greater on OHV-use sites relative to non-use sites.
- BHCO abundance was a factor of .48 less on OHV-use sites relative to non-use sites.
- A one unit increase in rain resulted in a gain in total richness by 9%, migrant abundance by 45%, migrant diversity by 29%, and migrant richness by 33%.
- A one unit increase in temperature decreased total abundance by 26%, total diversity by 15%, total richness by 19%.

Table 4. The 95% confidence interval for the least-squared means of OHV status on avian abundance, diversity, and richness for individual, pooled, and total number of species. Only models in which a significant effect of OHV was found are shown. All values have been log-transformed.

Model	CI lower OHV allowed	CI upper OHV allowed	CI lower No OHV	CI upper No OHV	Conclusion
Total abundance	11.98	15.07	17.49	21.91	lower on OHV sites
Total S-W Index					
Total richness	5.59	6.42	6.47	7.36	lower on OHV sites
Mig. abundance	2.47	3.85	4.84	7.70	lower on OHV sites
Mig. S-W Index					
Mig. richness					
Breeder abundance	9.11	11.49	11.86	14.90	lower on OHV sites
Breeder S-W Index					
Breeder richness	3.99	4.52	4.53	5.07	lower on OHV sites
MODO	2.03	3.34	3.79	6.12	lower on OHV sites
ATFL					
BRSP	0.25	0.76	1.24	3.45	lower on OHV sites
GAQU					
BTGN					
VERD	0.85	1.21	0.57	0.84	greater on OHV sites
WCSP					
CACW	0.43	0.66	0.67	0.96	lower on OHV sites
OCWA	0.19	0.32	0.37	0.56	lower on OHV sites
BUOR					
WAVI	0.07	0.15	0.27	0.39	lower on OHV sites
NAWA					
WIWA					
LBWO					
WEFL					
BHCO	0.10	0.19	0.23	0.37	lower on OHV sites
LOSH	0.08	0.18	0.20	0.34	lower on OHV sites
BHGR					

Mean OHV effect:
We estimated the least squares mean for each level of OHV status (non-use and use) for 13 models in which OHV status was significant in the *Significant covariate* analysis. Because the least squares mean also takes into account other variables in the model (i.e. temperature and rainfall) when calculating an estimated mean for OHV status, it may produce slightly different results (wider or narrower confidence intervals) than the likelihood ratio test and corresponding standard errors from the original analysis for significant covariates. However, for each of the 13 models the confidence intervals for use and non-use OHV estimates did not overlap. In all but one case (Verdin) abundance or richness was less on OHV-use sites than non-use sites.

Analyses of density using DISTANCE

We found that due to severe problems with heaping (low frequencies of detections close to the observer, with much higher frequencies at specific distances for each species), small sample sizes, and surveyors' tendencies to not always record distances to the exact meter (instead occasionally recording distances in bins), abundance estimates based on estimates of detectability were not helpful in relating patterns of abundance to covariates in the study area. For this reason, we assumed detectability to equal 1 in our modeling presented above.

Detection functions: The detection functions for Ash-throated Flycatchers, Brewer's Sparrows, Bullock's Orioles, Cactus Wrens, Gambel's Quails, Mourning Doves, Verdin, and White-crowned Sparrows indicated a significant lack of fit (P<0.05), although it was close for Cactus Wrens and Verdin. Visual inspection of these probability density function graphs indicated that the Brown-headed Cowbird lacks data in first bin and possible heaping in 40-50m bin; Brewer's Sparrow heaping at 30-40m bin; Black-tailed Gnatcatcher heaping at the 20-30m bin; Bullock's Oriole heaping at 40-50m bin; Cactus Wren lack of data at the first bin and 20-30m bin; Gambel's Quail with many problems: sparse data 0-40m and then severe heaping at 40-50m; Mourning Dove large heap at 0-10m, perhaps due to flushing a very large flock off of a point; Verdin with scant data between 30-50m; White-crowned Sparrow with severe heaping at 20-30m. The most egregious of these were Mourning Dove and Gambel's Quail. Though heaping is common in bird surveys that assess for detectability over distance, heaping was particularly problematic and data sets generally small. Despite these problems, we proceeded with our analyses.

Density estimates using Distance: Stratification by year and OHV status increased the number of parameters in each model. The model with stratification was best supported by the data for ATFL, BRSP, BUOR, GAQU, MODO, and WCSP; but not for BHCO, BTGN, CACW, OCWA, and VERD.

We examined the confidence intervals (Appendix B) to determine differences in density among years and from OHV status. However, for nearly all species, the confidence intervals overlapped. However, we did find that:

- There were significantly more Brown-headed Cowbirds in non-OHV sites in 2004
- Mourning Dove numbers were highly variable among years.
- There were significantly more White-crowned Sparrows on OHV sites in 2004 relative to non OHV-use sites.

2.4 BREEDING SPECIES DIVERSITY

The El Centro FO has expressed interest in a spatial depiction of breeding species diversity across the study area, to provide foci for conservation planning. The figures below present breeding species diversity means for each point count station, averaged across 2004-2007.

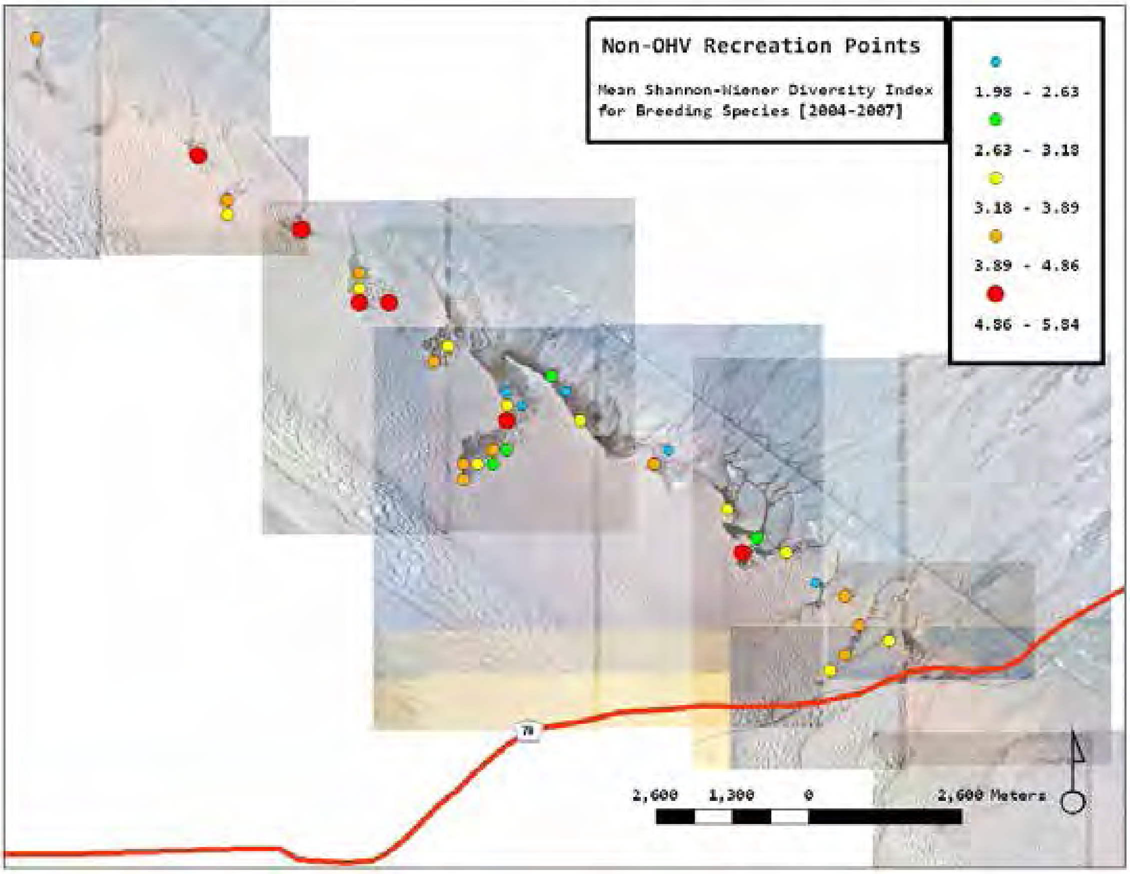

Figure 6. Breeding species richness in the ADWZ [non-use] area, averaged over 2004-2007.

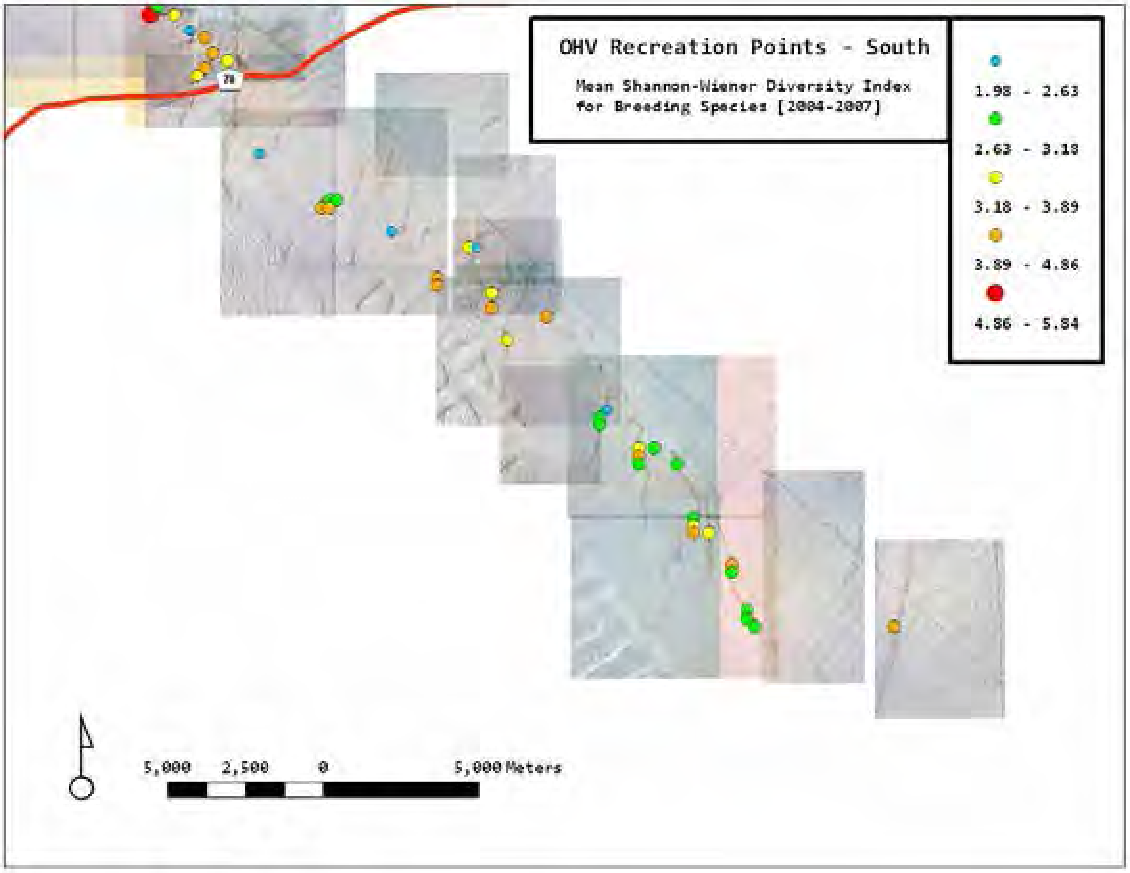

Figure 7. Breeding species richness in the IDSZ [OHV-use permitted] area, averaged over 2004-2007.

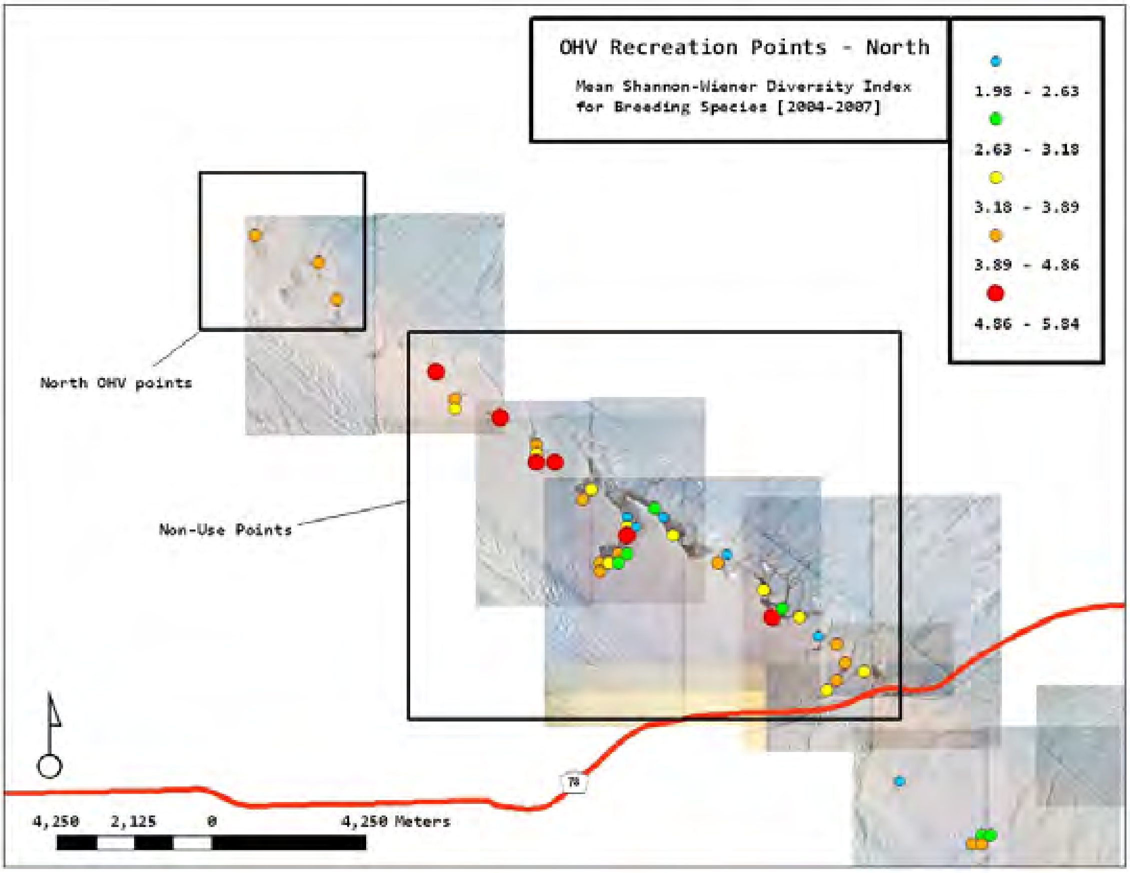

Figure 8. Breeding species richness in the IDNZ [OHV-use permitted] area, averaged over 2004-2007. Due to scale, and for reference, the ADWZ area is also depicted to the south.

2.5 DISCUSSION

Abundance, diversity, richness

We found that over the course of the study, non-OHV sites in the North Algodones Dunes Wilderness yielded significantly higher estimates of migrant bird abundance, breeding bird abundance, and breeding species richness than sites where OHV-use is permitted. We found that winter/spring precipitation (November 1 – May 31) was positively correlated to migrant abundance, diversity, and richness, and that winter temperature was negatively correlated with all migrant parameters, and breeding species abundance as well.

For species-specific abundance estimates of the most common 18 species, we found that 7 species had significantly higher abundances within the North Algodones Dunes Wilderness, and one (Verdin) had significantly lower abundances within the NAD Wilderness (Table 2). Winter/spring precipitation was significantly and positively correlated with the abundances of eight species, and winter temperature was negatively correlated with the abundances of 7 species (Table 2).

Migrant species responses to winter/spring precipitation match patterns observed at simultaneously surveyed sites across the Lower Colorado River Valley (CM *in prep*), where migrant abundance and richness rapidly rise in response to increases in precipitation, particularly as distance from riparian refugia (such as the Colorado River or Bill Williams River) accumulates.

We did not find a significant relationship between winter/precipitation and breeding species abundance and richness, and this matches patterns other PRBO woodland sites in the region as well. For breeding species, it appears that it is the winter/spring precipitation *one year prior* (in essence, a one-year time lag) that impacts breeding species richness and abundance via productivity in the previous breeding season (CM *in prep*). For example, PRBO has found that during the course of the study (2004-2008), highest breeding species estimates and abundance tended to be in 2006, the driest winter/spring of the study. This is because the *previous* winter/spring was very wet, and productivity was at its highest level observed from 2004-2008 (CM *in prep*). We did not analyze this time lag for breeding species at the Algodones Dunes, for we have only just discovered this pattern at our other sites and did not anticipate it in time for this analysis. But the fact that within-year winter/spring precipitation was not significantly correlated to breeding parameters at the Algodones Dunes (just as at other PRBO microphyll woodland sites) suggests that a similar time-lag pattern may drive breeding species numbers at the Algodones Dunes as well.

Vegetation Assessment

The BLM has not conducted habitat/vegetation assessments at the Algodones Dunes points. As a result, although we have found significantly more breeders and migrants at non-OHV use sites within the North Algodones Dunes Wilderness, these differences should not be assumed to result from recreation pressure alone. Rather, the habitat within the North Algodones Dunes Wilderness may simply be of higher quality than habitat outside the Wilderness. There is circumstantial evidence that this is true: for example, 11 out of 12 Crissal Thrasher detections and 2 out of 2 Gila Woodpecker detections were within the North Algodones Dunes Wilderness– species which tend to only be found in the densest microphyll woodland habitat with the largest trees (CM *in prep*).

If there are differences in habitat quality between open and closed areas, are these differences due to habitat degradation from OHV use, or simply due to natural differences in physiography? The El Centro Field Office has a great opportunity here to quantitatively demonstrate whether OHVs do in fact degrade habitat to the point that migrant and breeding species of birds may no longer use it. Further, as recreation pressure increases, the BLM must have a baseline by which to measure future habitat degradation. We strongly recommend that the BLM El Centro Field Office conduct vegetation assessments on all points for these reasons, using methods standardized with vegetation assessments that PRBO has conducted throughout southeastern California and western Arizona.

In other locations, we have found that actual OHV use on the ground does not necessarily conform to management units (McCreedy (2006). Thus, we also recommend that the BLM record annual measures of distance-to-trail and trail density at each point in order to better classify points according to their true use. Ideally, the BLM would combine these metrics with trail-counters that would measure use on an hourly basis, for comparison with similar data at the Chemehuevi Wash, San Bernardino County (McCreedy *in prep*), as well as to give the BLM a better sense of how different use rates manifest themselves in the landscape, in order to develop indices of use when trail-counters are not feasible.

Distance Sampling, Sample Size, and Survey Recommendations

For reasons described above, we elected to use indices of abundance in our analyses (assuming detection probability =1) rather than abundance estimates derived from program DISTANCE. This need is reflected in Johnson (2008):

> *Although distance sampling is ideally suited for certain situations, such as tortoise surveys in which distance from the observer is the primary factor influencing detection, the role of distance sampling for birds has been somewhat controversial. The requirement for a large number of detections to estimate a detectability function is one concern. Standard recommendations are for 60-100 detections per species, which basically eliminates the use of distance sampling for all but the commonest species, which typically are of lesser conservation interest (859).*

Computation of abundance estimates that include detectability will become more feasible when funding is secured to survey all 140 of originally-selected points. Data heaping at species-specific distances was often much more severe than patterns observed in other studies, and we suggest that it may benefit the BLM to employ more surveyors to eliminate potential survey bias.

In addition, while exact distances were occasionally recorded, distances were often recorded in bins. All PRBO sites in the region have been surveyed to exact meters since 2005, and we encourage this level of precision for Algodones Dunes sites as well. To avoid false-precision, we have truncated detections at 100m, referring to all detections beyond 100m as ">100". We suggest perhaps raising this truncation level to 150m, thus recording exact distances up to 150m, and all detections beyond as ">150m". These suggestions will help us to better fit detectability function models in the future.

In general, parameter estimates for the Algodones Dunes study area were somewhat higher than for other sites in the region (CM *in prep*). This was surprising, for while the

North Algodones Dunes Wilderness certainly contains quality habitat, it on a glance did not seem of markedly higher quality than other PRBO woodland sites with lower parameter estimates. One possible cause for elevated estimates is that detections of juvenile birds at the Algodones Dunes were included with other detections for analysis. Juvenile birds should be denoted with a "J" for each detection, in order to be filtered from analyses. We are unsure if juveniles were excluded from data provided by the BLM (for example, Loggerhead Shrike estimates seemed particularly high, and juvenile shrikes are frequently encountered during the point counting season). We stress that the BLM should ensure that no juvenile birds are included in analyses in the future.

Seventy of the approximately 140 originally-designed points have been surveyed from 2004-2007. It is not clear as to how these 70 points were selected. If these 70 points were not selected randomly from the larger 140-point set, then inferences should not be made between the Algodones Dunes data and data from other regional PRBO sites. The origin of the 70 point subset should be determined before regional inclusion of the Algodones data proceeds. Ideally, all 140 originally designed points would be surveyed in the future.

We also suggest that the BLM work to mix surveyors due to patterns in the data that may stem from surveyor bias. For example, Verdin was the only species found to be significantly more abundant in the open areas than in the closed area. This is striking, because Verdin likely respond to woodland habitat characteristics in a similar fashion to other species found much more frequently in the closed area than in the open area. Upon further inspection, the number of Verdin detected during the study were: 91 in 2004, 28 in 2005, 112 in 2006, and 10 in 2007. While these numbers match a pattern of one-year lag (wet 2003 and 2005 produced high numbers of Verdin in 2004 and 2006), the extreme between-year variation is striking, particularly as we have found that of all study species, Verdin productivity was least effected by the 2006 and 2007 droughts (CM *in prep*). Although less Verdin were found in the North Algodones Dunes Wilderness every season, only 7 were found in the Wilderness in 2005 which is again striking, as 2004 was not a particularly dry season. In addition, surveyors reported generally higher abundances of migrants such as Warbling Vireos and Orange-crowned Warblers than seen at other PRBO woodland sites, but the overall species composition for the Algodones Dunes is much simpler than the migrant species composition seen at other PRBO woodland sites. This pattern may result from a real phenomenon where fewer species use the Algodones Dunes on migration, but in greater numbers than at other wash sites in the region. Conversely, it may signal that unknown migrants are more conservatively mis-identified as just a handful of the most common migrant species at these sites.

Trends

When working in Sonoran Desert microphyll woodland habitats, it is imperative to gather multiple years of data in order to account for high variation in weather conditions (CM *in prep*). While the Algodones Dunes data set accounts for wet, normal, and dry years of winter/spring precipitation, it will require additional years of sampling for trend analysis (described above). We recommend at least six, and perhaps seven consecutive years of spring point counts in order to measure potential trends in parameter estimates between open and closed areas.

APPENDIX A. Individual Species Frequencies, 2004-2007 (breeding species in bold)

Common Name	Scientific Name	Frequency
Mourning Dove	*Zenaida macroura*	**1151**
Ash-throated Flycatcher	*Myiarchus cinerascens*	**515**
Brewer's Sparrow	*Spizella breweri*	372
Gambel's Quail	*Callipepla gambelii*	**356**
Black-tailed Gnatcatcher	*Polioptila melanura*	**265**
Verdin	*Auriparus flaviceps*	**241**
White-crowned Sparrow	*Zonotrichia leucophrys*	208
Cactus Wren	*Campylorhynchus brunneicapillus*	**188**
Orange-crowned Warbler	*Vermivora celata*	132
Bullock's Oriole	*Icterus bullockii*	**131**
Warbling Vireo	*Vireo gilvus*	108
Nashville Warbler	*Vermivora ruficapilla*	105
Wilson's Warbler	*Wilsonia pusilla*	81
Ladder-backed Woodpecker	*Picoides scalaris*	**78**
Western Flycatcher	*Empidonax difficilis*	67
Brown-headed Cowbird	*Molothrus ater*	**64**
Loggerhead Shrike	*Lanius ludovicianus*	**58**
Black-headed Grosbeak	*Pheucticus melanocephalus*	50
Western Kingbird	*Tyrannus verticalis*	**49**
White-winged Dove	*Zenaida asiatica*	**45**
LeConte's Thrasher	*Toxostoma lecontei*	**44**
Black-throated Gray Warbler	*Dendroica nigrescens*	40
Northern Mockingbird	*Mimus polyglottos*	**39**
Red-tailed Hawk	*Buteo jamaicensis*	**29**
Western Tanager	*Piranga ludoviciana*	29
Yellow-rumped Warbler	*Dendroica coronata*	27
Crissal Thrasher	*Toxostoma crissale*	**24**
Lesser Goldfinch	*Carduelis psaltria*	**20**
Great-horned Owl	*Bubo virginianus*	**19**
Greater Roadrunner	*Geococcyx californicus*	**18**
Townsend's Warbler	*Dendroica townsendi*	15
House Finch	*Carpodacus mexicanus*	**13**
Green-tailed Towhee	*Pipilo chlorurus*	12
Ruby-crowned Kinglet	*Regulus calendula*	10
House Wren	*Troglodytes aedon*	9
Blue-gray Gnatcatcher	*Polioptila caerulea*	9
Lincoln's Sparrow	*Melospiza lincolnii*	9

APPENDIX A. Individual Species Frequencies, 2004-2007 (breeding species in bold)

Common Name	Scientific Name	Frequency
Costa's Hummingbird	***Calypte costae***	**8**
Phainopepla	***Phainopepla nitens***	**8**
Turkey Vulture	*Cathartes aura*	7
Chipping Sparrow	*Spizella passerina*	7
Eurasian Collared-Dove	***Streptopelia decaocto***	**6**
Common Yellowthroat	*Geothlypis trichas*	6
Lazuli Bunting	*Passerina amoena*	6
Western Meadowlark	*Sturnella neglecta*	6
Lesser Nighthawk	***Chordeiles acutipennis***	**5**
Anna's Hummingbird	***Calypte anna***	**5**
Gray Flycatcher	*Empidonax wrightii*	5
Spotted Towhee	*Pipilo maculatus*	5
Calliope Hummingbird	*Stellula calliope*	4
Western Wood-pewee	*Contopus sordidulus*	4
Empidonax species	*Empidonax*	4
Yellow Warbler	*Dendroica petechia*	4
Black-throated Sparrow	***Amphispiza bilineata***	**4**
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	4
Rufous Hummingbird	*Selasphorus rufus*	3
Northern Flicker	*Colaptes auratus*	3
Cassin's Vireo	*Vireo cassinii*	3
Hermit Thrush	*Catharus guttatus*	3
Red-winged Blackbird	*Agelaius phoeniceus*	3
Northern Harrier	*Circus cyaneus*	2
Cooper's Hawk	*Accipiter cooperii*	2
Gila Woodpecker	***Melanerpes uropygialis***	**2**
Swainson's Thrush	*Catharus ustulatus*	2
European Starling	*Sturnus vulgaris*	2
Lucy's Warbler	***Vermivora luciae***	**2**
MacGillivray's Warbler	*Oporornis tolmiei*	2
Western Scrub-jay	*Aphelocoma californica*	1
Hermit Warbler	*Dendroica occidentalis*	1
Vesper Sparrow	*Pooecetes gramineus*	1
TOTAL SPECIES		70

APPENDIX B. Density Estimates Derived from Program DISTANCE

DENSITY ESTIMATES FROM PROGRAM DISTANCE.
DATA LABELS ARE AS FOLLOWS:
  STRATA # 01 TO 04 ARE OHV FROM YEARS 2004-2007 RESPECTIVELY
  STRATA # 05 TO 08 ARE NON-OHV FROM YEARS 2004-2007 RESPECTIVELY
DIFFERENCES WHERE THE CI DON'T OVERLAP (AND ARE SIGNIFICANT) ARE HIGHLIGHTED.

ATFL

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.77519E-01	25.84	141.59	0.46894E-01	0.12815
Stratum: 2 Hazard/Hermite	D	0.10638	23.73	160.99	0.67000E-01	0.16889
Stratum: 3 Hazard/Hermite	D	0.18109	71.42	89.77	0.50575E-01	0.64842
Stratum: 4 Hazard/Hermite	D	0.94889E-01	23.59	199.83	0.59969E-01	0.15014
Stratum: 5 Hazard/Hermite	D	0.64274E-01	18.98	213.80	0.44362E-01	0.93125E-01
Stratum: 6 Hazard/Hermite	D	0.16811	66.86	61.28	0.49858E-01	0.56684
Stratum: 7 Hazard/Hermite	D	0.56859E-01	21.50	264.89	0.37415E-01	0.86409E-01
Stratum: 8 Hazard/Hermite	D	0.80180E-01	16.98	250.42	0.57529E-01	0.11175

BHCO

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.00000				
Stratum: 2 Hazard/Hermite	D	0.28936E-01	82.69	12.61	0.60544E-02	0.13830
Stratum: 3 Hazard/Hermite	D	0.32058E-01	113.46	11.45	0.43711E-02	0.23511
Stratum: 4 Hazard/Hermite	D	0.72003E-02	81.12	10.16	0.14815E-02	0.34993E-01
Stratum: 5 Hazard/Hermite	D	0.21101E-01	55.59	73.74	0.75030E-02	0.59341E-01
Stratum: 6 Hazard/Hermite	D	0.87780E-02	77.81	16.20	0.20445E-02	0.37689E-01
Stratum: 7 Hazard/Hermite	D	0.35905E-01	165.57	17.36	0.31937E-02	0.40367

Stratum: 8 Hazard/Hermite	D	0.11330E-01	90.16	18.43	0.22474E-02 0.57121E-01

BRSP

		Estimate	%CV	df	95% Confidence Interval
Stratum: 1 Hazard/Hermite	D	0.15007	88.45	27.22	0.31560E-01 0.71361
Stratum: 2 Hazard/Hermite	D	0.94774E-01	58.30	161.00	0.32566E-01 0.27581
Stratum: 3 Hazard/Hermite	D	0.47302E-01	118.04	27.63	0.69714E-02 0.32096
Stratum: 4 Hazard/Hermite	D	0.61170E-01	71.08	75.04	0.17112E-01 0.21866
Stratum: 5 Hazard/Hermite	D	0.12011	43.73	185.35	0.52628E-01 0.27414
Stratum: 6 Hazard/Hermite	D	0.64502E-01	44.54	197.99	0.27876E-01 0.14925
Stratum: 7 Hazard/Hermite	D	0.34401	36.09	239.66	0.17267 0.68537
Stratum: 8 Hazard/Hermite	D	0.75427E-01	65.78	204.31	0.23126E-01 0.24601

BTGN

		Estimate	%CV	df	95% Confidence Interval
Stratum: 1 Hazard/Hermite	D	0.21419	39.85	70.04	0.99593E-01 0.46064
Stratum: 2 Hazard/Hermite	D	0.74667E-01	26.83	150.50	0.44351E-01 0.12571
Stratum: 3 Hazard/Hermite	D	0.74896E-01	23.24	179.60	0.47634E-01 0.11776
Stratum: 4 Hazard/Hermite	D	0.51516E-01	36.89	55.64	0.25185E-01 0.10537
Stratum: 5 Hazard/Hermite	D	0.13557	24.52	114.91	0.84007E-01 0.21877
Stratum: 6 Hazard/Hermite	D	0.35363E-01	66.45	13.56	0.96269E-02 0.12990
Stratum: 7 Hazard/Hermite	D	0.59435E-01	28.63	96.59	0.34047E-01 0.10376
Stratum: 8 Hazard/Hermite	D	0.13786	109.42	31.89	0.22619E-01 0.84029

BUOR

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.32703E-02	74.07	146.00	0.88495E-03	0.12085E-01
Stratum: 2 Hazard/Hermite	D	0.54803	******	5.01	0.11650E-02	257.80
Stratum: 3 Hazard/Hermite	D	0.30803E-01	41.02	128.11	0.14116E-01	0.67214E-01
Stratum: 4 Hazard/Hermite	D	0.54993E-01	47.96	191.60	0.22414E-01	0.13493
Stratum: 5 Hazard/Hermite	D	0.11688E-01	77.90	26.73	0.28431E-02	0.48052E-01
Stratum: 6 Hazard/Hermite	D	0.10010	85.70	161.00	0.23119E-01	0.43339
Stratum: 7 Hazard/Hermite	D	0.39436E-01	59.83	127.13	0.13199E-01	0.11783
Stratum: 8 Hazard/Hermite	D	0.64381E-01	38.70	224.25	0.30834E-01	0.13443

CACW

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.23256E-01	44.67	36.90	0.97991E-02	0.55191E-01
Stratum: 2 Hazard/Hermite	D	0.15376	91.71	20.08	0.30148E-01	0.78423
Stratum: 3 Hazard/Hermite	D	0.24604E-01	26.76	161.55	0.14638E-01	0.41355E-01
Stratum: 4 Hazard/Hermite	D	0.22428E-01	31.16	116.07	0.12272E-01	0.40990E-01
Stratum: 5 Hazard/Hermite	D	0.30833E-01	24.36	168.20	0.19194E-01	0.49530E-01
Stratum: 6 Hazard/Hermite	D	0.63111E-01	30.07	145.90	0.35284E-01	0.11288
Stratum: 7 Hazard/Hermite	D	0.29784E-01	24.86	218.42	0.18383E-01	0.48257E-01
Stratum: 8 Hazard/Hermite	D	0.32152E-01	34.94	63.94	0.16321E-01	0.63337E-01

GAQU

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.51713E-01	177.64	16.17	0.41276E-02	0.64791
Stratum: 2 Hazard/Hermite	D	0.10098	37.66	187.36	0.49227E-01	0.20715
Stratum: 3 Hazard/Hermite	D	0.36635E-01	46.82	192.34	0.15225E-01	0.88153E-01
Stratum: 4 Hazard/Hermite	D	0.56933E-01	40.76	208.57	0.26287E-01	0.12331
Stratum: 5 Hazard/Hermite	D	0.39351E-01	43.63	67.38	0.17104E-01	0.90531E-01
Stratum: 6 Hazard/Hermite	D	0.74755E-01	34.28	149.40	0.38689E-01	0.14444
Stratum: 7 Hazard/Hermite	D	0.16849	36.62	241.17	0.83777E-01	0.33885
Stratum: 8 Hazard/Hermite	D	0.40067E-01	31.69	226.65	0.21779E-01	0.73712E-01

MODO

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.79577E-01	28.75	146.00	0.45593E-01	0.13889
Stratum: 2 Hazard/Hermite	D	11.512	507.54	47.28	0.30022	441.47
Stratum: 3 Hazard/Hermite	D	0.87813E-01	34.85	268.27	0.45093E-01	0.17101
Stratum: 4 Hazard/Hermite	D	0.30386	29.77	352.66	0.17131	0.53896
Stratum: 5 Hazard/Hermite	D	0.15962	44.65	151.39	0.68743E-01	0.37062
Stratum: 6 Hazard/Hermite	D	0.16806	27.34	217.22	0.99011E-01	0.28527
Stratum: 7 Hazard/Hermite	D	298.04	146.47	380.33	36.322	2445.6
Stratum: 8 Hazard/Hermite	D	0.36912	27.51	424.70	0.21707	0.62767

OCWA

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.54505E-01	99.66	146.00	0.10559E-01	0.28136
Stratum: 2 Hazard/Hermite	D	0.20802E-01	111.88	4.18	0.17766E-02	0.24357
Stratum: 3 Hazard/Hermite	D	0.61799E-01	50.22	48.23	0.23821E-01	0.16033
Stratum: 4 Hazard/Hermite	D	0.72392E-01	67.29	147.38	0.21636E-01	0.24222
Stratum: 5 Hazard/Hermite	D	0.54966E-01	83.80	20.59	0.12039E-01	0.25095
Stratum: 6 Hazard/Hermite	D	0.75988E-01	56.76	52.92	0.26326E-01	0.21934
Stratum: 7 Hazard/Hermite	D	0.20119	77.94	63.35	0.50784E-01	0.79701
Stratum: 8 Hazard/Hermite	D	0.14274	47.49	94.99	0.58308E-01	0.34945

VERD

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite	D	0.63888E-01	28.15	118.21	0.36976E-01	0.11039
Stratum: 2 Hazard/Hermite	D	0.35256E-01	39.08	67.14	0.16612E-01	0.74821E-01
Stratum: 3 Hazard/Hermite	D	0.59338E-01	19.31	245.99	0.40709E-01	0.86491E-01
Stratum: 4 Hazard/Hermite	D	0.11663E-01	60.63	18.23	0.36039E-02	0.37744E-01
Stratum: 5 Hazard/Hermite	D	0.97656E-01	108.70	36.34	0.16294E-01	0.58530
Stratum: 6 Hazard/Hermite	D	0.71179E-02	62.04	16.49	0.21295E-02	0.23791E-01
Stratum: 7 Hazard/Hermite	D	0.48736E-01	27.26	140.71	0.28706E-01	0.82743E-01
Stratum: 8 Hazard/Hermite	D	0.31160E-01	93.68	7.01	0.47722E-02	0.20346

WCSP

		Estimate	%CV	df	95% Confidence Interval	
Stratum: 1 Hazard/Hermite						
	D	0.47573	73.96	84.77	0.12793	1.7692
Stratum: 2 Hazard/Hermite						
	D	0.11300	74.92	142.60	0.30204E-01	0.42273
Stratum: 3 Hazard/Hermite						
	D	0.81409E-01	99.11	198.00	0.15930E-01	0.41603
Stratum: 4 Hazard/Hermite						
	D	0.44697E-01	152.64	6.09	0.30814E-02	0.64837
Stratum: 5 Hazard/Hermite						
	D	0.55049E-01	43.20	137.33	0.24293E-01	0.12474
Stratum: 6 Hazard/Hermite						
	D	0.80858	42.95	217.12	0.35939	1.8192
Stratum: 7 Hazard/Hermite						
	D	0.76151E-01	100.00	208.00	0.14752E-01	0.39309
Stratum: 8 Hazard/Hermite						
	D	0.42559E-01	119.06	4.60	0.35675E-02	0.50771

APPENDIX C. Breeding Species List Used in Analyses

Abert's Towhee
American Kestrel
Anna's Hummingbird
Ash-throated Flycatcher
Bell's Vireo
Bendire's thrasher
Black-chinned Hummingbird
Brown-headed Cowbird
Black-tailed Gnatcatcher
Black-throated Sparrow
Brown-crested Flycatcher
Bullock's Oriole
Cactus Wren
Canyon Wren
Costa's Hummingbird
Common Raven
Crissal Thrasher
Curve-billed Thrasher
Eurasian Collared-dove
Gambel's Quail
Great-horned Owl
Gila Woodpecker
Gilded Flicker
Greater Roadrunner
House Finch
Horned Lark
Ladder-backed Woodpecker
Lawrence's Goldfinch
LeConte's Thrasher
Lesser Goldfinch
Lesser Nighthawk
Loggerhead Shrike
Long-eared Owl
Lucy's Warbler
Mourning Dove
Northern Mockingbird
Northern Rough-winged Swallow
Phainopepla
Rock Wren
Red-tailed Hawk
Say's Phoebe
Verdin
Western Kingbird
Western Screech-owl
White-winged Dove

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